General

Guideline Title

Clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with acute carbon monoxide poisoning.

Bibliographic Source(s)

Wolf SJ, Maloney GE, Shih RD, Shy BD, Brown MD, American College of Emergency Physicians. Clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with acute carbon monoxide poisoning. Ann Emerg Med. 2017 Jan;69(1):98-107.e6. [37 references] PubMed

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Wolf SJ, Lavonas EJ, Sloan EP, Jagoda AS, American College of Emergency Physicians. Clinical policy: critical issues in the management of adult patients presenting to the emergency department with acute carbon monoxide poisoning. Ann Emerg Med. 2008 Feb;51(2):138-52. [71 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Definitions for the strength of evidence (Class I-III) and strength of recommendations (A-C) are provided at the end of the "Major Recommendations" field.

1. In emergency department (ED) patients with suspected acute carbon monoxide (CO) poisoning, can noninvasive carboxyhemoglobin (COHb) measurement be used to accurately diagnose CO toxicity?
   Level A recommendations. None specified.

   Level B recommendations. Do not use noninvasive COHb measurement (pulse CO oximetry) to diagnose CO toxicity in patients with suspected acute CO poisoning.

   Level C recommendations. None specified.

2. In ED patients diagnosed with acute CO poisoning, does hyperbaric oxygen (HBO_2) therapy as compared with normobaric oxygen therapy improve long-term neurocognitive outcomes?
   Level A recommendations. None specified.

Level B recommendations. Emergency physicians should use HBO_2 therapy or high-flow normobaric therapy for acute CO-poisoned patients. It remains unclear whether HBO_2 therapy is superior to normobaric oxygen therapy for improving long-term neurocognitive outcomes.

Level C recommendations. None specified.

3. In ED patients diagnosed with acute CO poisoning, can cardiac testing be used to predict morbidity or mortality?
Level A recommendations. None specified.

Level B recommendations. In ED patients with moderate to severe CO poisoning, obtain an electrocardiogram (ECG) and cardiac biomarker levels to identify acute myocardial injury, which can predict poor outcome.

Level C recommendations. None specified.

Definitions

Strength of Evidence

*Literature Classification Schema**

Design/Class	Therapy†	Diagnosis‡	Prognosis§
1	Randomized, controlled trial or meta-analysis of randomized trials	Prospective cohort using a criterion standard or meta-analysis of prospective studies	Population prospective cohort or meta-analysis of prospective studies
2	Nonrandomized trial	Retrospective observational	Retrospective cohort Case control
3	Case series	Case series	Case series

*Some designs (e.g., surveys) will not fit this schema and should be assessed individually.

†Objective is to measure therapeutic efficacy comparing interventions.

‡Objective is to determine the sensitivity and specificity of diagnostic tests.

§Objective is to predict outcome, including mortality and morbidity.

*Approach to Downgrading Strength of Evidence**

	Design/Class		
Downgrading	**1**	**2**	**3**
None	I	II	III
1 level	II	III	X
2 levels	III	X	X
Fatally flawed	X	X	X

*See the "Description of Methods Used to Analyze the Evidence" field for more information.

Strength of Recommendations

Level A recommendations. Generally accepted principles for patient care that reflect a high degree of clinical certainty (e.g., based on evidence from 1 or more Class of Evidence I or multiple Class of Evidence II studies).

Level B recommendations. Recommendations for patient care that may identify a particular strategy or range of strategies that reflect moderate clinical certainty (e.g., based on evidence from 1 or more Class of Evidence II studies or strong consensus of Class of Evidence III studies).

Level C recommendations. Recommendations for patient care that are based on evidence from Class of Evidence III studies or, in the absence of any adequate published literature, based on expert consensus. In instances where consensus recommendations are made, "consensus" is placed in

parentheses at the end of the recommendation.

There are certain circumstances in which the recommendations stemming from a body of evidence should not be rated as highly as the individual studies on which they are based. Factors such as heterogeneity of results, uncertainty about effect magnitude and consequences, and publication bias, among others, might lead to such a downgrading of recommendations.

Clinical Algorithm(s)

None provided

Scope

Disease/Condition(s)

Acute carbon monoxide (CO) poisoning

Guideline Category

Evaluation

Management

Clinical Specialty

Emergency Medicine

Internal Medicine

Intended Users

Physicians

Guideline Objective(s)

To derive evidence-based recommendations to answer the following clinical questions:

- In emergency department patients with suspected acute carbon monoxide (CO) poisoning, can noninvasive carboxyhemoglobin measurement be used to accurately diagnose CO toxicity?
- In emergency department patients diagnosed with acute CO poisoning, does hyperbaric oxygen therapy as compared with normobaric oxygen therapy improve long-term neurocognitive outcomes?
- In emergency department patients diagnosed with acute CO poisoning, can cardiac testing be used to predict morbidity or mortality?

Target Population

Adult patients presenting to the emergency department with suspected or diagnosed acute carbon monoxide (CO) poisoning

Note: This guideline is not intended to be used for out-of-hospital emergency care patients, pediatric populations, pregnant patients and fetal exposures, those with chronic CO poisoning, or patients with delayed presentations (more than 24 hours after cessation of exposure) of CO poisoning.

Interventions and Practices Considered

1. Noninvasive carboxyhemoglobin (COHb) measurement (pulse carbon monoxide [CO] oximetry) (not recommended)
2. Hyperbaric oxygen (HBO_2) therapy or high-flow normobaric oxygen therapy
3. Cardiac testing (i.e., electrocardiogram [ECG], cardiac biomarker levels)

Major Outcomes Considered

- Long-term neurologic sequelae (e.g., memory loss, impaired concentration or language, depression, parkinsonism, lifelong disability)
- Accurate diagnoses of suspected carbon monoxide (CO) exposure
- Efficacy of hyperbaric oxygen (HBO_2) therapy in preventing neurologic sequelae
- Mortality
- Morbidity

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Searches of MEDLINE, MEDLINE InProcess, Scopus, Web of Science, and the Cochrane Database were performed. All searches were limited to English-language sources, human studies, and adults. Specific key words/phrases, years used in the searches, dates of searches, and study selection are identified under each critical question in the original guideline document. In addition, relevant articles from the bibliographies of included studies and more recent articles identified by committee members and reviewers were included.

Number of Source Documents

Critical Question 1

One hundred thirty-eight articles were identified in the search; 13 articles were selected from the search results for further review, with 5 studies included for this critical question.

Critical Question 2

Two hundred sixteen articles were identified in the search; 43 articles were selected from the search results for further review, with 7 studies included for this critical question.

Critical Question 3

Ninety-seven articles were identified in the search; 28 articles were selected from the search results for further review, with 2 studies included for this critical question.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Strength of Evidence

Literature Classification Schema*

Design/Class	Therapy†	Diagnosis‡	Prognosis§
1	Randomized, controlled trial or meta-analysis of randomized trials	Prospective cohort using a criterion standard or meta-analysis of prospective studies	Population prospective cohort or meta-analysis of prospective studies
2	Nonrandomized trial	Retrospective observational	Retrospective cohort Case control
3	Case series	Case series	Case series

*Some designs (e.g., surveys) will not fit this schema and should be assessed individually.

†Objective is to measure therapeutic efficacy comparing interventions.

‡Objective is to determine the sensitivity and specificity of diagnostic tests.

§Objective is to predict outcome, including mortality and morbidity.

Approach to Downgrading Strength of Evidence*

	Design/Class		
Downgrading	**1**	**2**	**3**
None	I	II	III
1 level	II	III	X
2 levels	III	X	X
Fatally flawed	X	X	X

*See the "Description of Methods Used to Analyze the Evidence" field for more information.

Methods Used to Analyze the Evidence

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Assessment of Classes of Evidence

All articles used in the formulation of this clinical policy were graded by at least 2 methodologists and assigned a Class of Evidence. Each article was assigned a design class, with design 1 representing the strongest study design and subsequent design classes (e.g., design 2, design 3) representing respectively weaker study designs for therapeutic, diagnostic, or prognostic clinical reports, or meta-analyses (see the "Rating Scheme for the Strength of the Evidence" field). Articles were then graded on dimensions related to the study's methodological features, such as randomization processes, blinding, allocation concealment, methods of data collection, outcome measures and their assessment, selection and misclassification biases, sample size, and generalizability. Using a predetermined process related to the study's design, methodological quality, and applicability to the critical question, articles received a final Class of Evidence grade (i.e., Class I, Class II, Class III, or Class X) (see the "Rating Scheme for the Strength of the Evidence" field). Articles identified with fatal flaws or that were ultimately not applicable to the critical question received a Class of Evidence grade "X" and were not used in formulating recommendations for this policy. Grading was done with respect to the specific critical questions; thus, the level of evidence for any one study may vary according to the question for which it is being considered. As such, it was possible for a single article to receive different Classes of Evidence as different critical questions were answered from the same study. Question-specific Classes of Evidence grading may be found in the Evidentiary Table in the original guideline document.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

This policy is a product of the American College of Emergency Physicians (ACEP) clinical policy development process, including expert review, and is based on the existing literature; when literature was not available, consensus of emergency physicians was used.

When possible, clinically oriented statistics (e.g., likelihood ratios [LRs], number needed to treat [NNT]) are presented to help the reader better understand how the results may be applied to the individual patient. For a definition of these statistical concepts, see Appendix C in the original guideline document.

Rating Scheme for the Strength of the Recommendations

Strength of recommendations regarding each critical question were made by subcommittee members using results from strength of evidence grading, expert opinion, and consensus among subcommittee members according to the following guidelines:

Strength of Recommendations

Level A recommendations. Generally accepted principles for patient care that reflect a high degree of clinical certainty (e.g., based on evidence from 1 or more Class of Evidence I or multiple Class of Evidence II studies).

Level B recommendations. Recommendations for patient care that may identify a particular strategy or range of strategies that reflect moderate clinical certainty (e.g., based on evidence from 1 or more Class of Evidence II studies or strong consensus of Class of Evidence III studies).

Level C recommendations. Recommendations for patient care that are based on evidence from Class of Evidence III studies or, in the absence of any adequate published literature, based on expert consensus. In instances where consensus recommendations are made, "consensus" is placed in parentheses at the end of the recommendation.

There are certain circumstances in which the recommendations stemming from a body of evidence should not be rated as highly as the individual studies on which they are based. Factors such as heterogeneity of results, uncertainty about effect magnitude and consequences, and publication bias, among others, might lead to such a downgrading of recommendations.

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

Expert review comments were received from emergency physicians, hyperbaric medicine specialists, medical toxicologists, the Council of Undersea and Hyperbaric Medicine Fellowship Directors, and the American College of Emergency Physicians (ACEP) Undersea and Hyperbaric Medicine Section leadership. The draft was available for comments during a 60-day open-comment period, with notices of the comment period sent in e-mails, published in *EM Today*, and posted on the ACEP Web site. The responses were used to further refine and enhance this policy; however, the responses do not imply endorsement of this clinical policy.

This clinical policy was approved by the ACEP Board of Directors on October 13, 2016.

This clinical policy was endorsed by the Emergency Nurses Association on November 28, 2016.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The type of supporting evidence is identified and graded for each recommendation (see "Major Recommendations" field).

Recommendations for question 1 were based on 1 Class II study and 4 Class III studies. Recommendations for question 2 were based on 4 Class II studies and 3 Class III studies. Recommendations for question 3 were based on 1 Class II study and 1 Class III study.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

See the "Potential Benefits" sections in Appendix D in the original guideline document for information on potential benefits of the specific interventions.

Potential Harms

See the "Potential Harms" sections in Appendix D in the original guideline document for information on potential harms of the specific interventions.

Qualifying Statements

Qualifying Statements

- Policy statements and clinical policies are the official policies of the American College of Emergency Physicians (ACEP) and, as such, are not subject to the same peer review process as articles appearing in the journal. Policy statements and clinical policies of ACEP do not necessarily reflect the policies and beliefs of *Annals of Emergency Medicine* and its editors.
- This policy is not intended to be a complete manual on the evaluation and management of patients with suspected or diagnosed carbon monoxide (CO) poisoning but rather a focused examination of critical issues that have particular relevance to the current practice of emergency medicine.
- It is the goal of the Clinical Policies Committee to provide an evidence-based recommendation when the medical literature provides enough quality information to answer a critical question. When the medical literature does not contain adequate empirical data to answer a critical question, the members of the Clinical Policies Committee believe that it is equally important to alert emergency physicians to this fact.
- This clinical policy is not intended to represent a legal standard of care for emergency physicians. Recommendations offered in this policy are not intended to represent the only diagnostic or management options available to the emergency physician. ACEP recognizes the importance of the individual physician's judgment and patient preferences. This guideline defines for the physician those strategies for which medical literature exists to provide support for answers to the critical questions addressed in this policy.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Mobile Device Resources

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

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Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2017 Jan

Guideline Developer(s)

American College of Emergency Physicians - Medical Specialty Society

Source(s) of Funding

The American College of Emergency Physicians (ACEP) was the funding source for this clinical policy.

Guideline Committee

American College of Emergency Physicians (ACEP) Clinical Policies Subcommittee (Writing Committee) on Carbon Monoxide Poisoning

ACEP Clinical Policies Committee (Oversight Committee)

Composition of Group That Authored the Guideline

Members of the Subcommittee on Carbon Monoxide Poisoning: Stephen J. Wolf, MD (*Subcommittee Chair*); Gerald E. Maloney, DO;

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Financial Disclosures/Conflicts of Interest

Relevant industry relationships: There were no relevant industry relationships disclosed by the subcommittee members for this topic.

Relevant industry relationships are those relationships with companies associated with products or services that significantly impact the specific aspect of disease addressed in the critical question.

Guideline Endorser(s)

Emergency Nurses Association - Professional Association

Guideline Status

This is the current release of the guideline.

This guideline updates a previous version: Wolf SJ, Lavonas EJ, Sloan EP, Jagoda AS, American College of Emergency Physicians. Clinical policy: critical issues in the management of adult patients presenting to the emergency department with acute carbon monoxide poisoning. Ann Emerg Med. 2008 Feb;51(2):138-52. [71 references]

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the American College of Emergency Physicians (ACEP) Web site .

A summary of this guideline optimized for mobile viewing is available under the CQ tab at the ACEP Web site .

Availability of Companion Documents

The following are available:

- American College of Emergency Physicians clinical policy development. 3 p. Available from the American College of Emergency Physicians (ACEP) Web site .
- ACEP clinical policy development process. Flow chart. 1 p. Available from the ACEP Web site

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on April 16, 2008. The information was verified by the guideline developer on May 16, 2008. This summary was updated by ECRI Institute on February 27, 2017. The updated information was verified by the guideline developer on February 28, 2017.

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